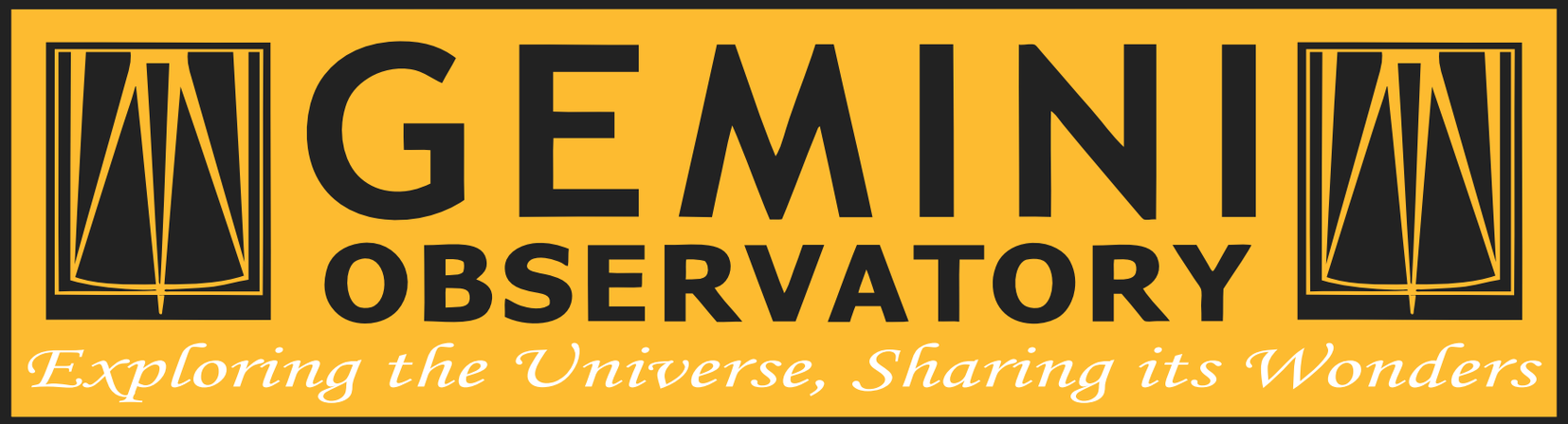


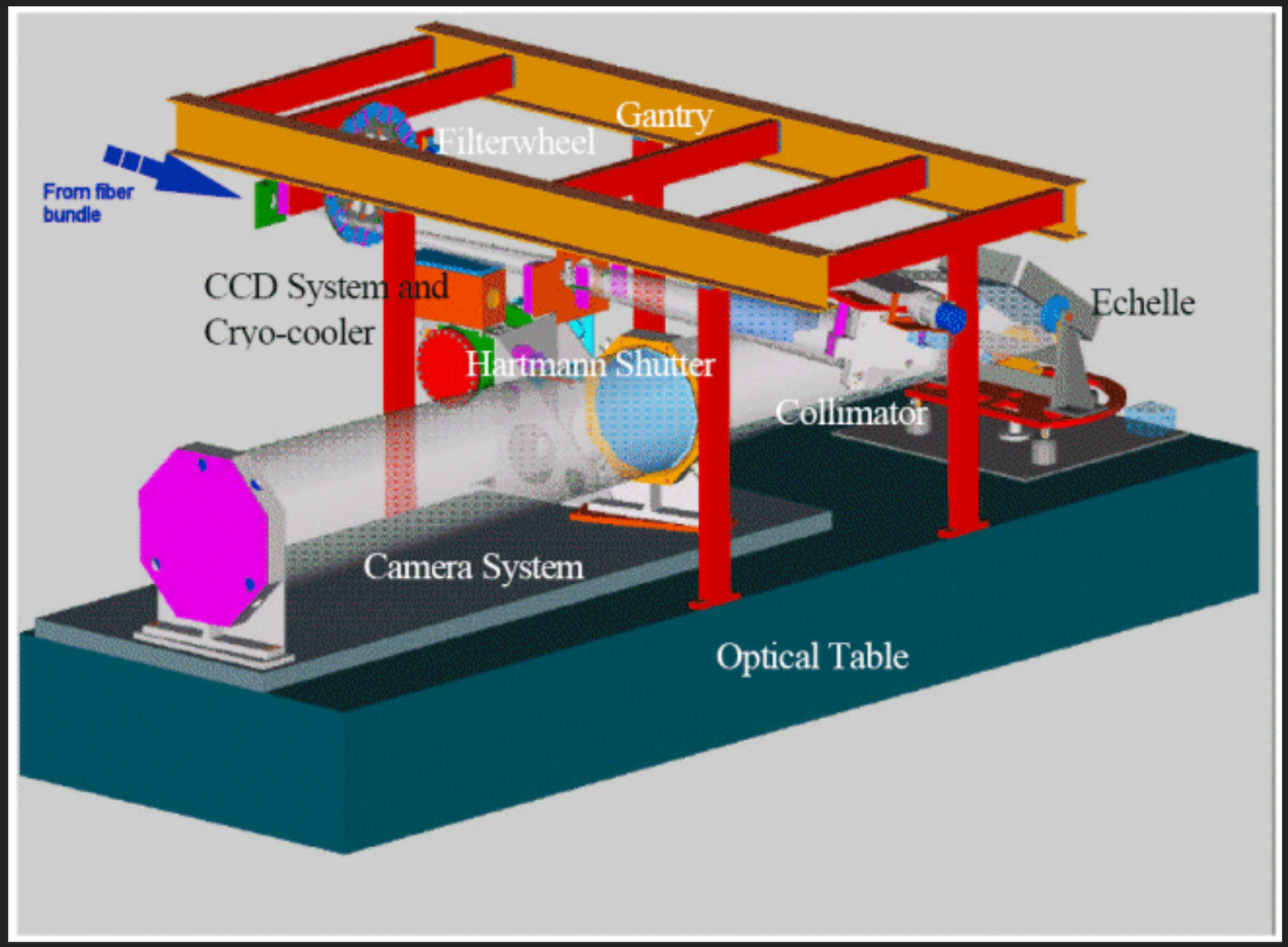
THE GEMINI HIGH-RESOLUTION OPTICAL SPECTROGRAPH

STEVE MARGHEIM - GEMINI OBSERVATORY

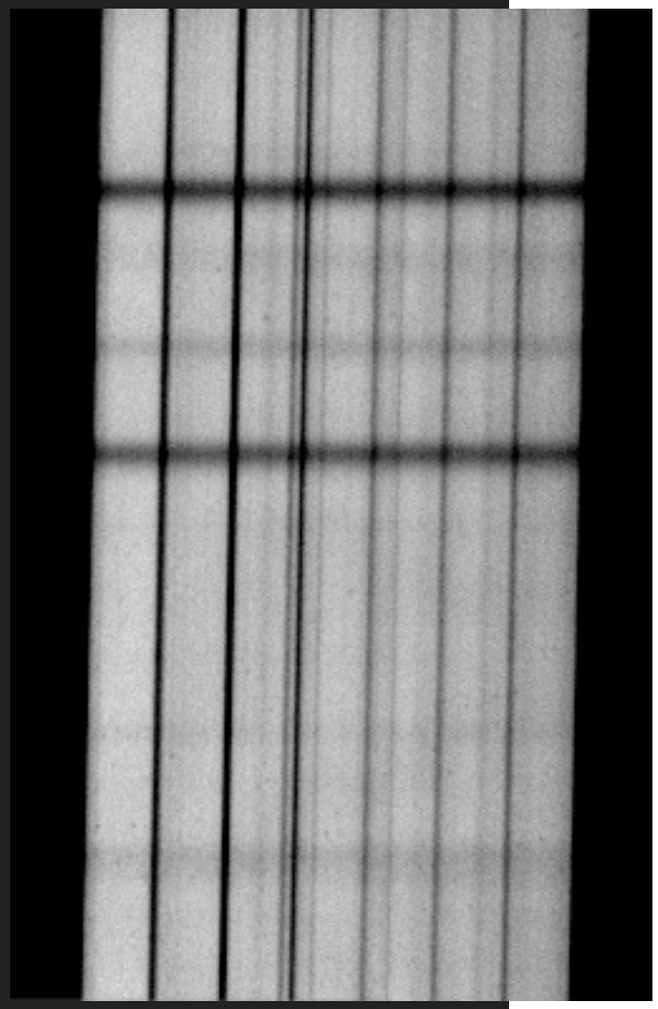
GHOST

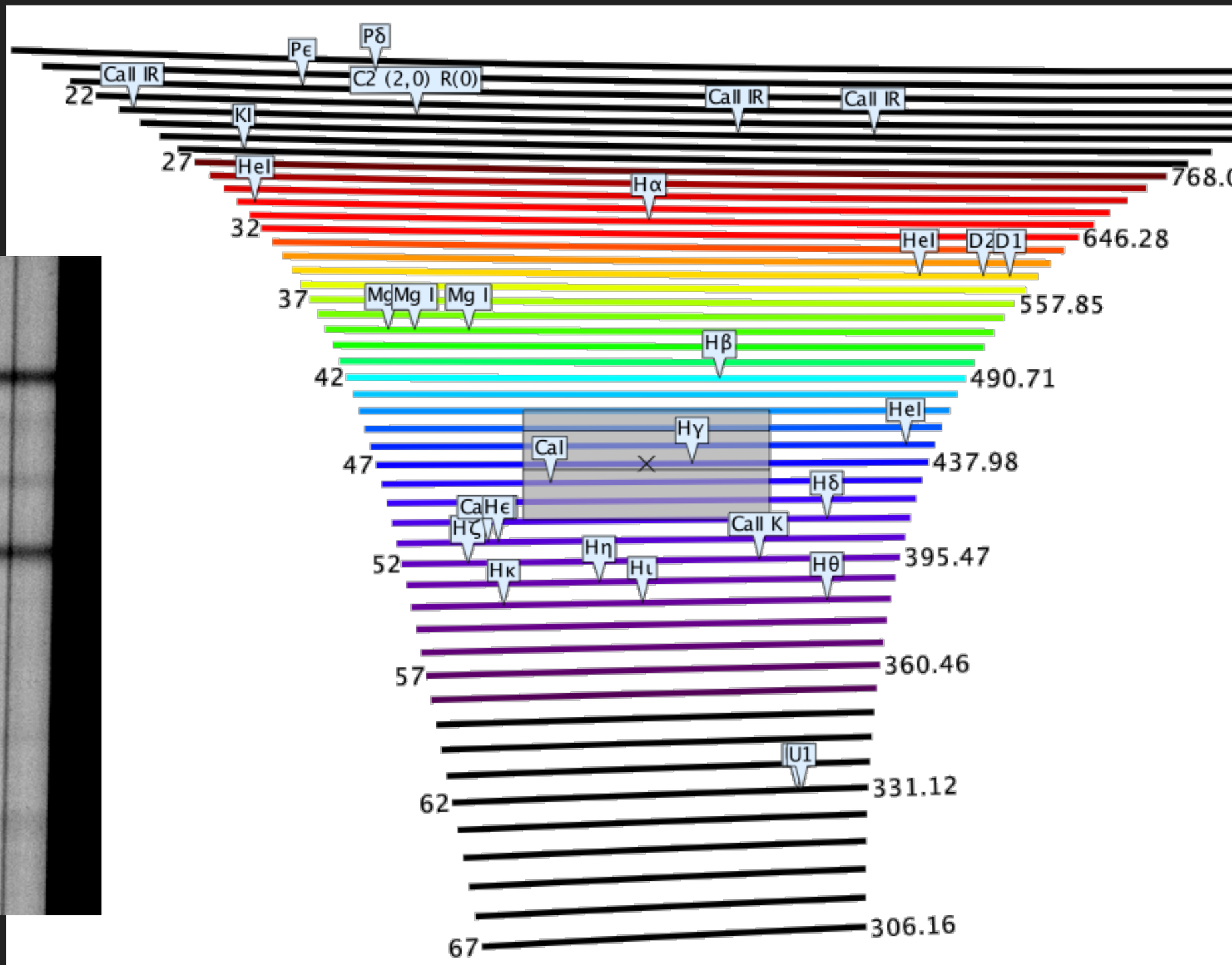
A BRIEF HISTORY OF HR SPECTROSCOPY AT GEMINI

- bHROS



A BRIEF HISTORY… 2





GENERATION #4 INSTRUMENTATION

GALACTIC STRUCTURE IN THE SURVEY AGE
A White Paper for the Gemini High-Resolution Spectrograph

Jennifer Johnson (Ohio State University)
Stefan Keller (Australian National University)
Kim Venn (University of Victoria)

GRACES

Gemini Remote Access to CFHT ESPaDOnS Spectrograph

Executive Summary

GRACES is offering a low-cost and easy-to-implement option to add high-resolution spectroscopic capabilities to Gemini North. Its predicament is based on (1) the closed proximity of the two facilities on the summit ridge of Maunakea, (2) ESPaDOnS, an efficient high-resolution (R~65,000 for 'object+sky' or ~80,000 for 'object only') cross-dispersed échelle spectrograph covering the whole visible spectrum in operation at CFHT, and (3) the availability of the instrument for at least 250 nights per year. ESPaDOnS has been used for the past five years as a spectro-polarimeter, with a blend of unique programs using its polarimetric capabilities for stellar magnetic field studies, and purely spectroscopic observations. Therefore, the instrument is by now very stable and well-characterized, and comes with an efficient reduction pipeline. The polarimetric capabilities of ESPaDOnS come from a module installed at the Cassegrain focus of the telescope. Such a module would have to be developed at Gemini if spectropolarimetry were to be of interest to the Gemini community. This aspect is not detailed in this document as it is not part of the call for white papers.

remely Metal-Poor Stars

hite Paper Submitted for

n Optical Spectroscopy

Understanding the Assembly History of the Milky Way with Observations of Dwarf Galaxies

A White Paper in Support of a High-Resolution Optical Spectrograph on Gemini

Anna Frebel, Harvard-Smithsonian Cf
Marla Geha, Yale U
Evan N. Kirby, C
Andy McWilliam, Observatories of the Ca
John Norris, Australian Nat
Matt Shetrone, McDonald Observat
Joshua D. Simon, Observatories of the Ca
Rosie Wyse, Johns Hopki
Kim Venn, University of V
Manuela Zoccali, Universida

THE NEXT GENERATION OF GLOBULAR CLUSTER STUDIES

A White Paper Submitted for Gemini's Proposed High-Resolution Optical Spectrograph

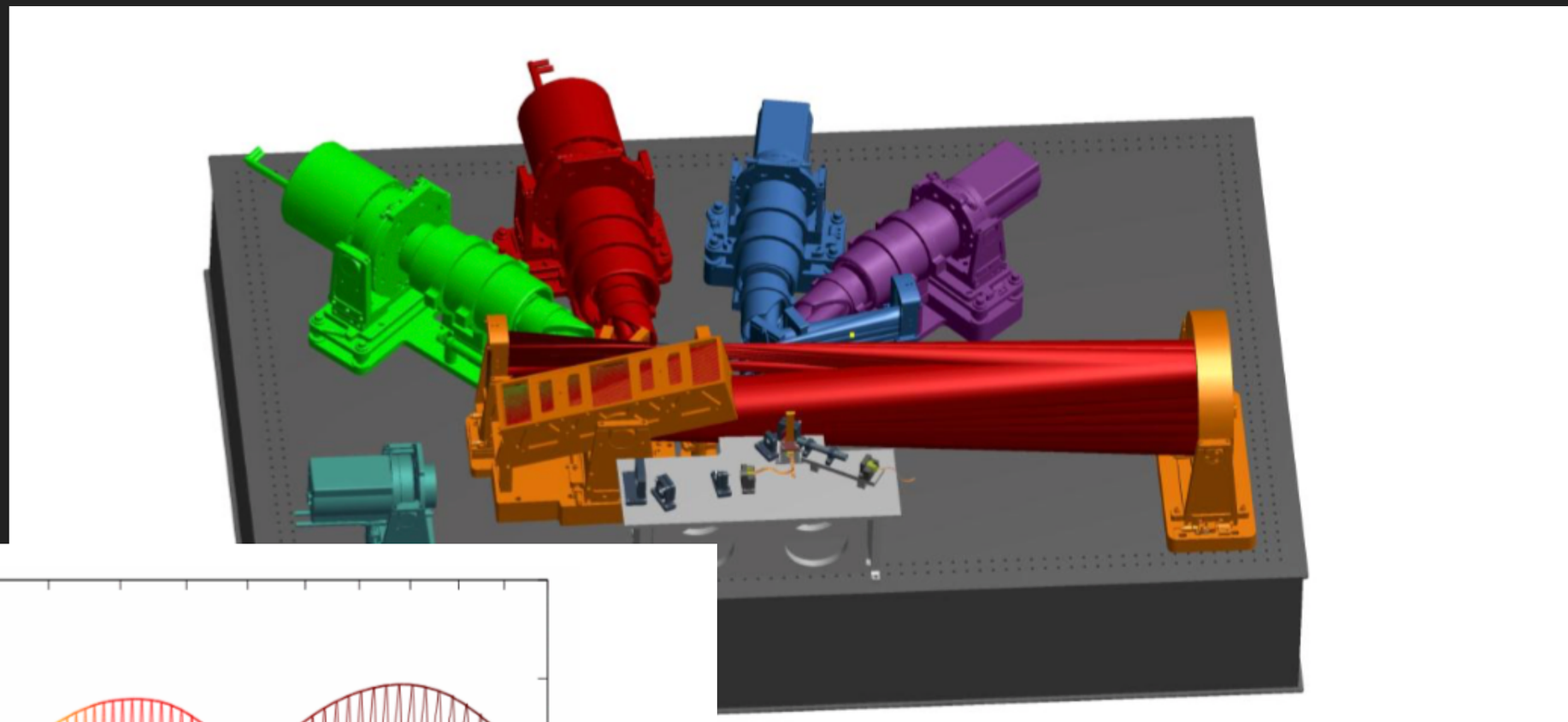
David Yong (Australian National University) & Ian U. Roederer (Carnegie Observatories)

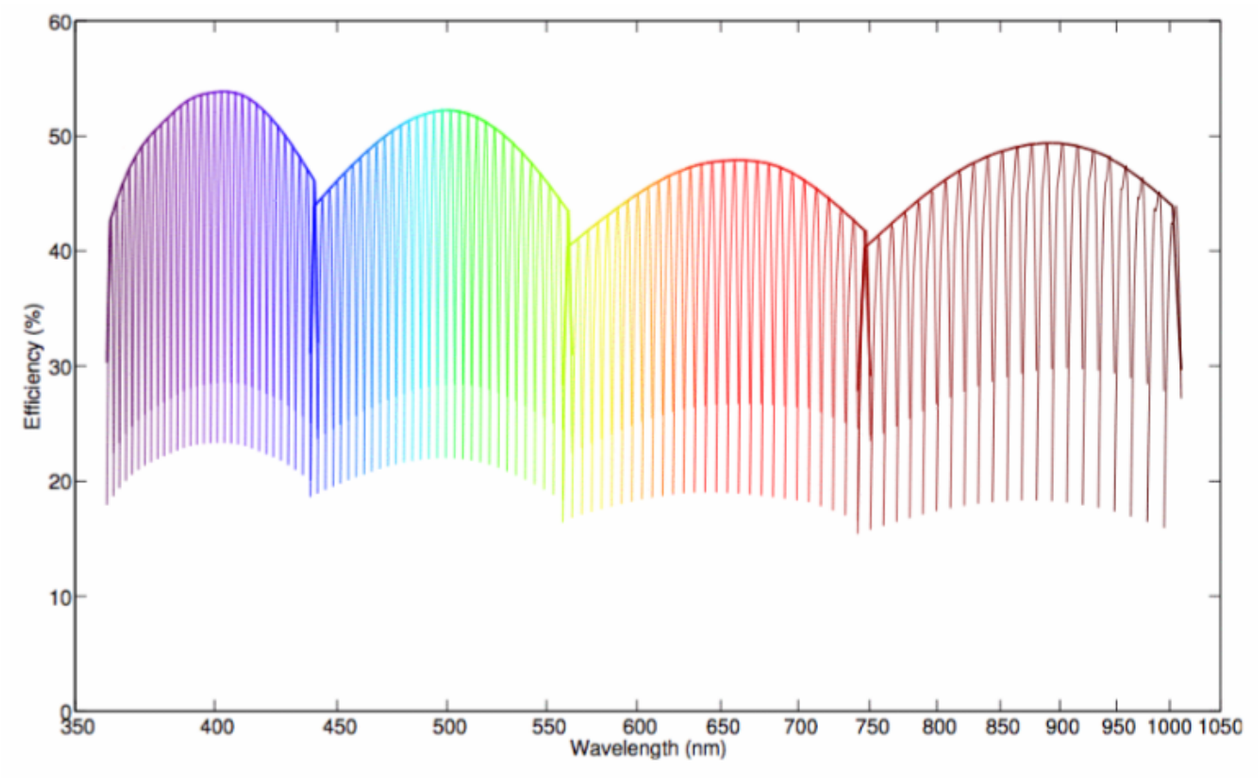
SCIENCE CASES -> WORKHORSE INSTRUMENT

- Call for Proposals for Conceptual Design Phase / Feasibility Studies

- Gemini funded 3 designs

ORIGINAL AAO DESIGN





THINGS FALL APART...

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Business Small Business Around NZ Economy Industries Property Personal Finance

Callaghan Innovation quits telescope contract

4:10 PM Thursday Aug 8, 2013

Manufacturing Science Technology

SHARE:

The government's new innovation agency has begun culling commercial activity that either doesn't fit its future operations or is judged to be unsustainable.

Mary Quinn, head of Callaghan Innovation.

That's led to the cancellation of a contract by KiwiStar, a highly specialised unit of six scientists and technicians shaping telescope glass and developing spectrographic instruments for use in telescopes, and invitation from Callaghan's chief executive Mary Quin for expressions of interest in KiwiStar as a business investment.

"Callaghan Innovation seeks to work with high value manufacturing sector Kiwi companies to help accelerate the commercialisation of innovation of businesses in New Zealand," said Quin in a statement. "It is not our mission or intent to own or operate business ourselves."

KiwiStar was to have undertaken a two year sub-contract with the Australian Astronomical Observatory, but the commercial risks associated with a contract that combined a fixed timeframe with a fixed fee meant Callaghan was "not comfortable with the level of risk," said Quin.

GHOS REBORN AS GHOST

GEMINI OBSERVATORY
Exploring the Universe, Sharing its Wonders

AAO

NRC·CNRC
Canada

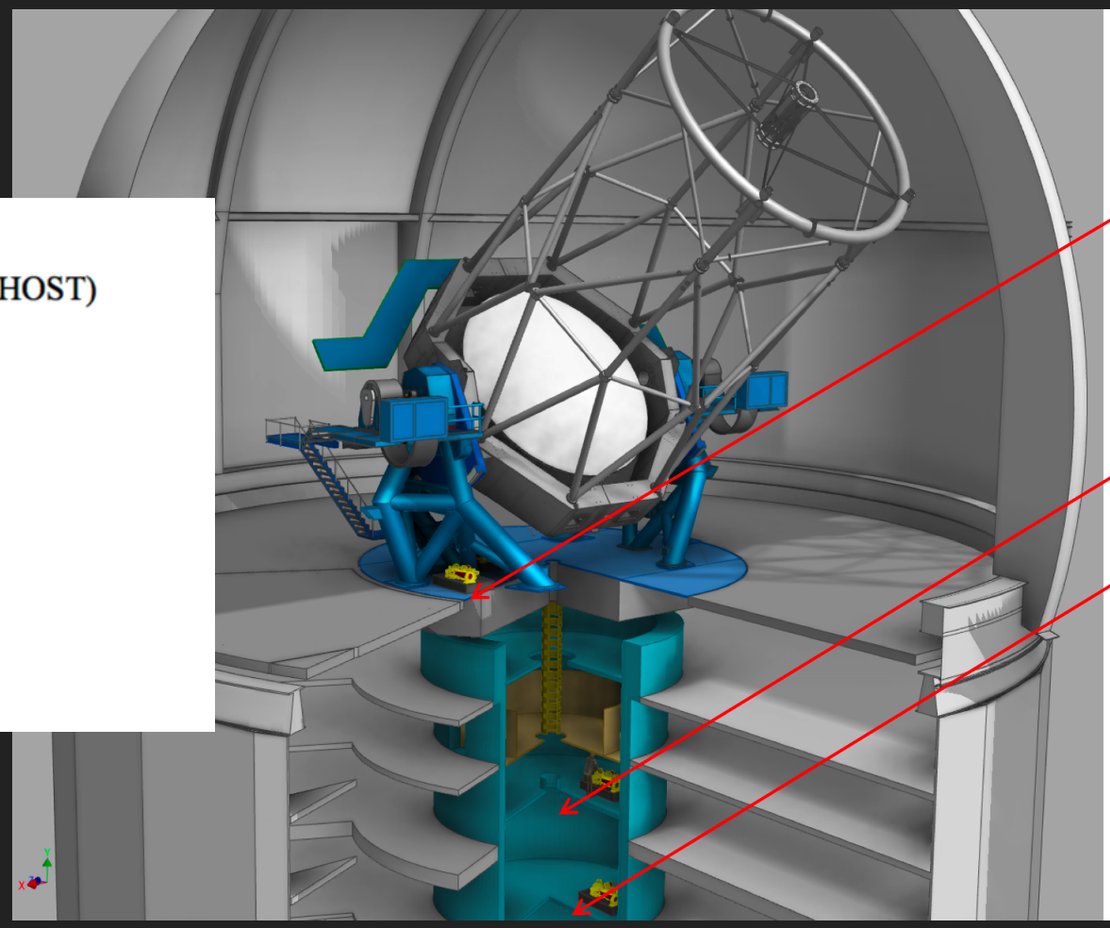
Australian National University

TRADE-DESIGN STUDIES

Gemini High-Resolution Optical Spectrograph (GHOST)
Optical Design Down-Select Document
GP-GHOST-PD-STUDY-002

Date: August 6th, 2014

Drafted by NRC
Release 1



OBSERVATIONAL PARAMETERS

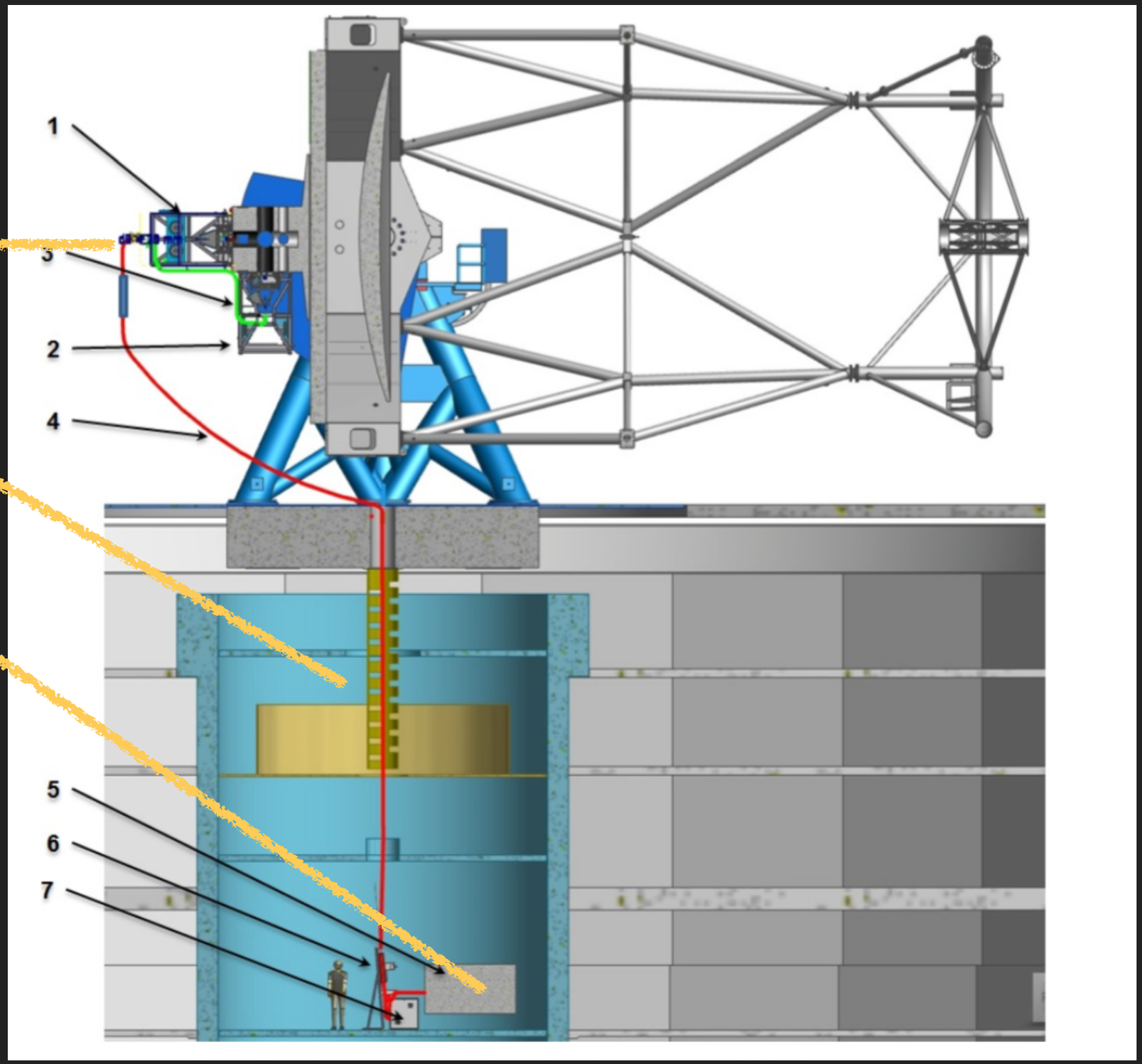
- Simultaneous Wavelength Coverage: 363 - 950 nm
- Resolution: Standard R=50,000; High R=75,000
- Limiting Magnitude ~18 at 450nm (30 sigma per res element)
- Multiplex: 2 objects in 7.5 arcmin FOV (standard res)
- Spatial sampling over 1.2 arcsec
- RV precision: Standard 600 m/s; High 10m/s

SCIENCE CASE COMPARISON WITH DESIGN

Science Req. / Science Case	1001: Wavelength range (nm)	1002: Resolution	1003: Mag. Limit	1004: Obj./ field	1005. RV prec.	1006: Obj. type	1007: Polarimetry
Stellar chemistry in stars with planets	380-950*	30k +45k	16	1	600	Point source	n/a
Galactic structure	350-930 310-930	35k	17	1	600	Point source	n/a
Extremely metal-poor stars	390-950*	15-40k	18	>1	600	Point source	n/a
Extreme metal-poor stars in dwarfs	360-960	20-60k	19	>1	600	Point source	n/a
Abundance studies of extra-galactic GCs	390-860	20-30k	19	>1	600	Point source	n/a
Globular cluster studies	350-800	30-60k	19	>1	600	Point source	n/a
Cool dwarfs	500-1000	30-60k	18	1	600	Point source	n/a
Astrophysics with open clusters	390-777 +300-1000	45-100k	14	>1	600	Point source	n/a
Dwarf galaxy shapes	520	20k	n/a	1	600	Extended object	n/a
Nucleo-chronometry of the oldest stars	330-870	60k	12	1	600	Point source	n/a
MW assembly history via dwarf galaxies	330-870 +420-700	20-40k	19	>1	600	Point source	n/a
GAIA Follow-up	450-700	40k	17	>1	600	Point source	n/a
Magnetic Fields in Star Formation/ exoplanets	380-950*	50-100k	11	>1	600	Point source	yes
Precision spectropolarimetry	390-950*	50-100k	11	1	600	Point source	yes
Exoplanets	400-900	75k	19	>1	1-50	Point source	n/a
Varying constants	400-900	75k	17	1	10	Point source	n/a
GRB spectroscopy	400-900	40k	14	1	600	Point source	n/a

OVERVIEW OF DESIGN

- Cassegrain unit
- Fiber cable
- Bench unit



CASSEGRAIN UNIT

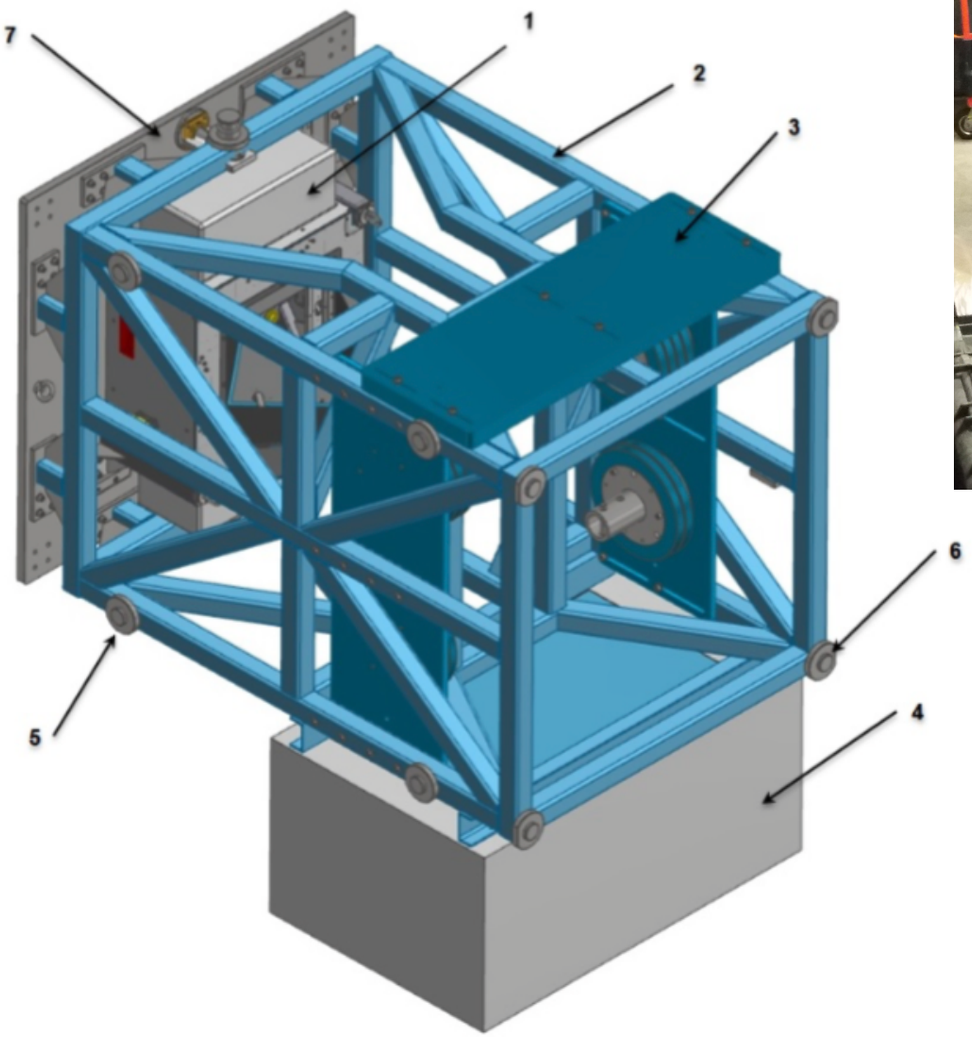


Figure 7 - Ghost Cassegrain Unit assembly
1 – IFU Frame Assembly; 2- Ballast Frame; 3 – Balance Weights; 4 – Electronics Cabinet; 5, 6 -Pads to interface with lifting platform; 7- Main Structural Plate.

CASS UNIT…2

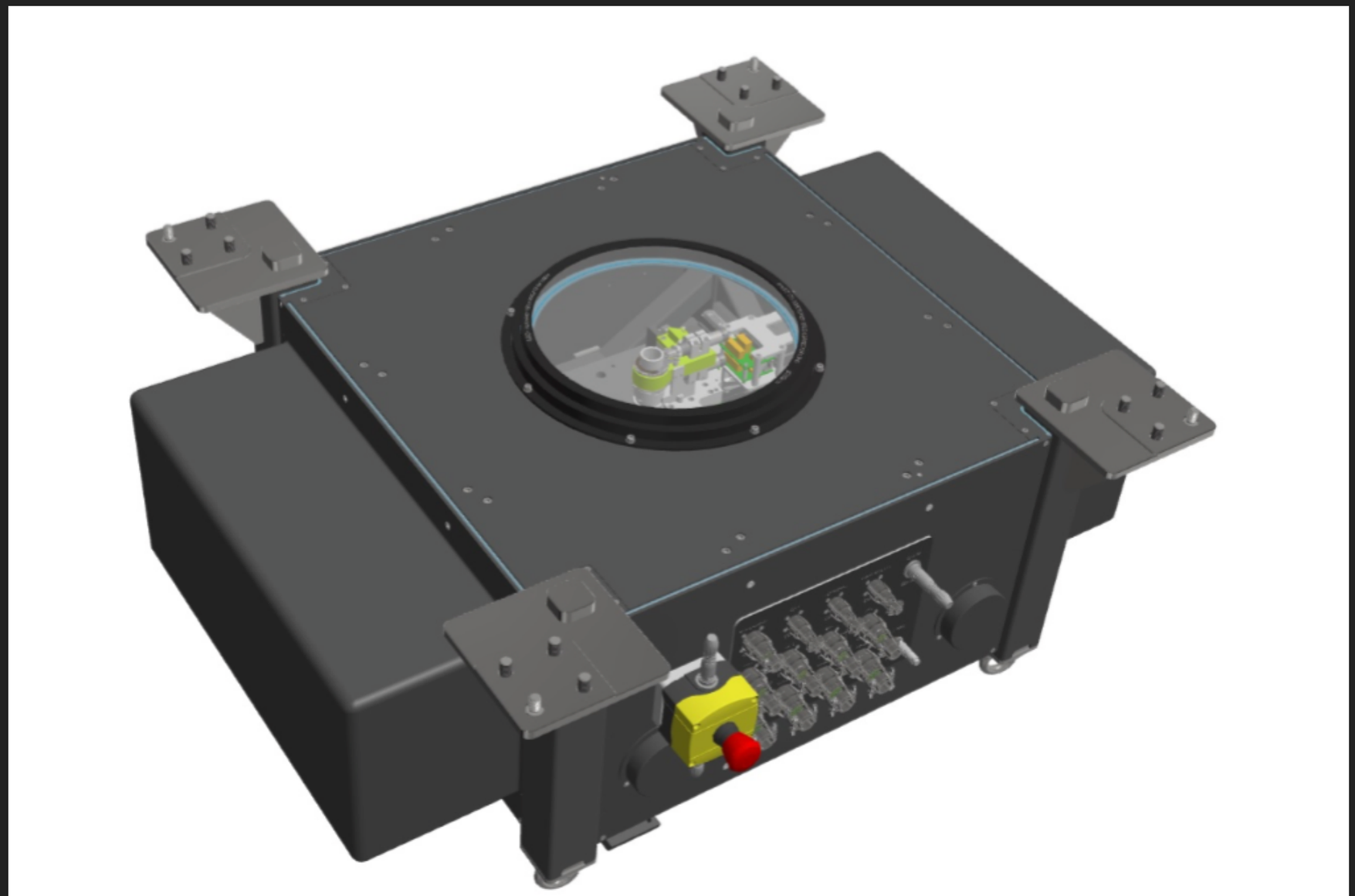


Figure 13 - Telecentricity lens mounted on the Lens Mounting Plate.

CASS UNIT…3

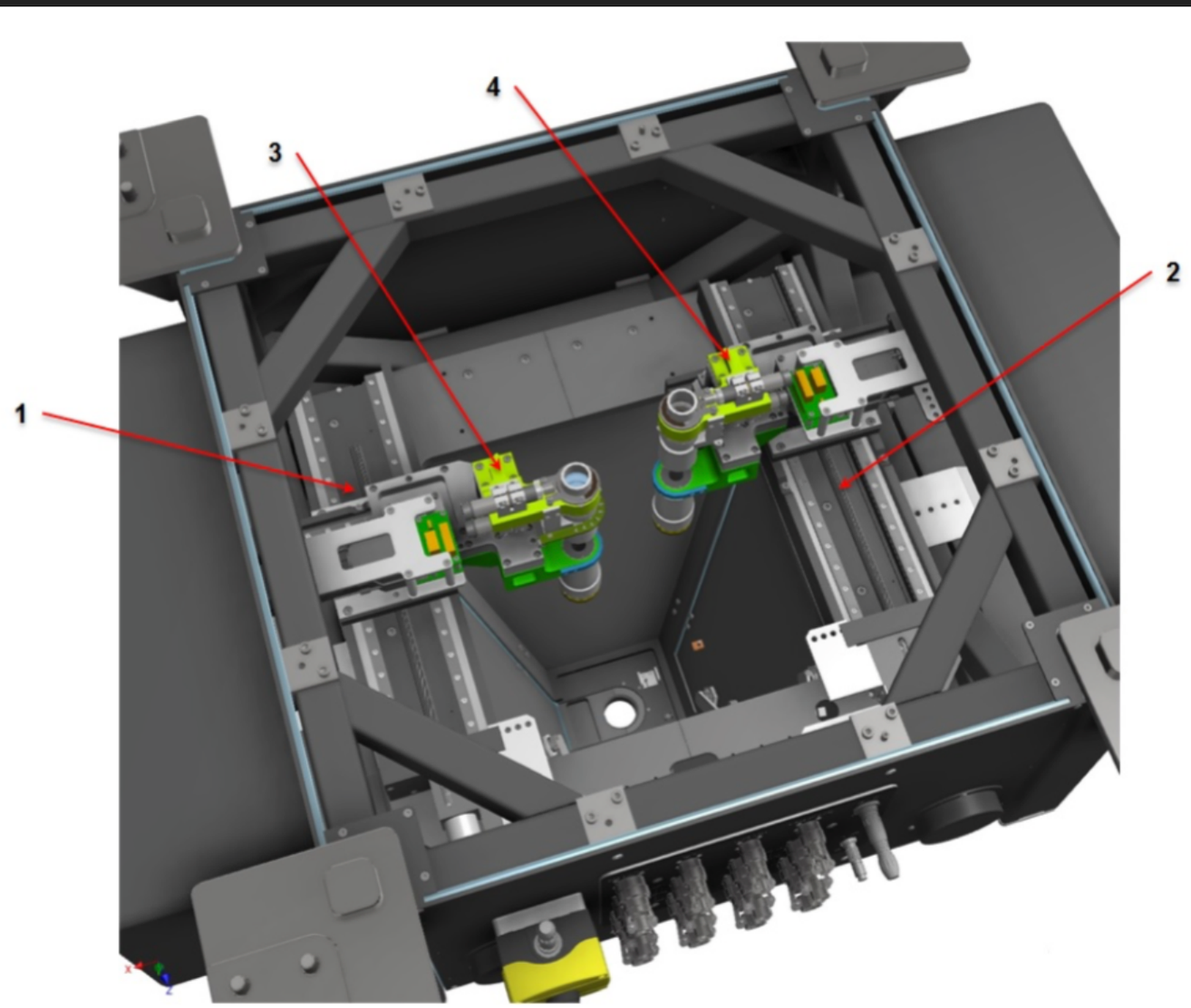


Figure 14 - IFU Positioners in IFU Frame.
Front panel and the lens removed.
1 – IFU 1 Linear Stages; 2 – IFU2 Linear stages; 3 – IFU1/ADC mount; 4 – IFU2/ADC mount

CASS UNIT…4

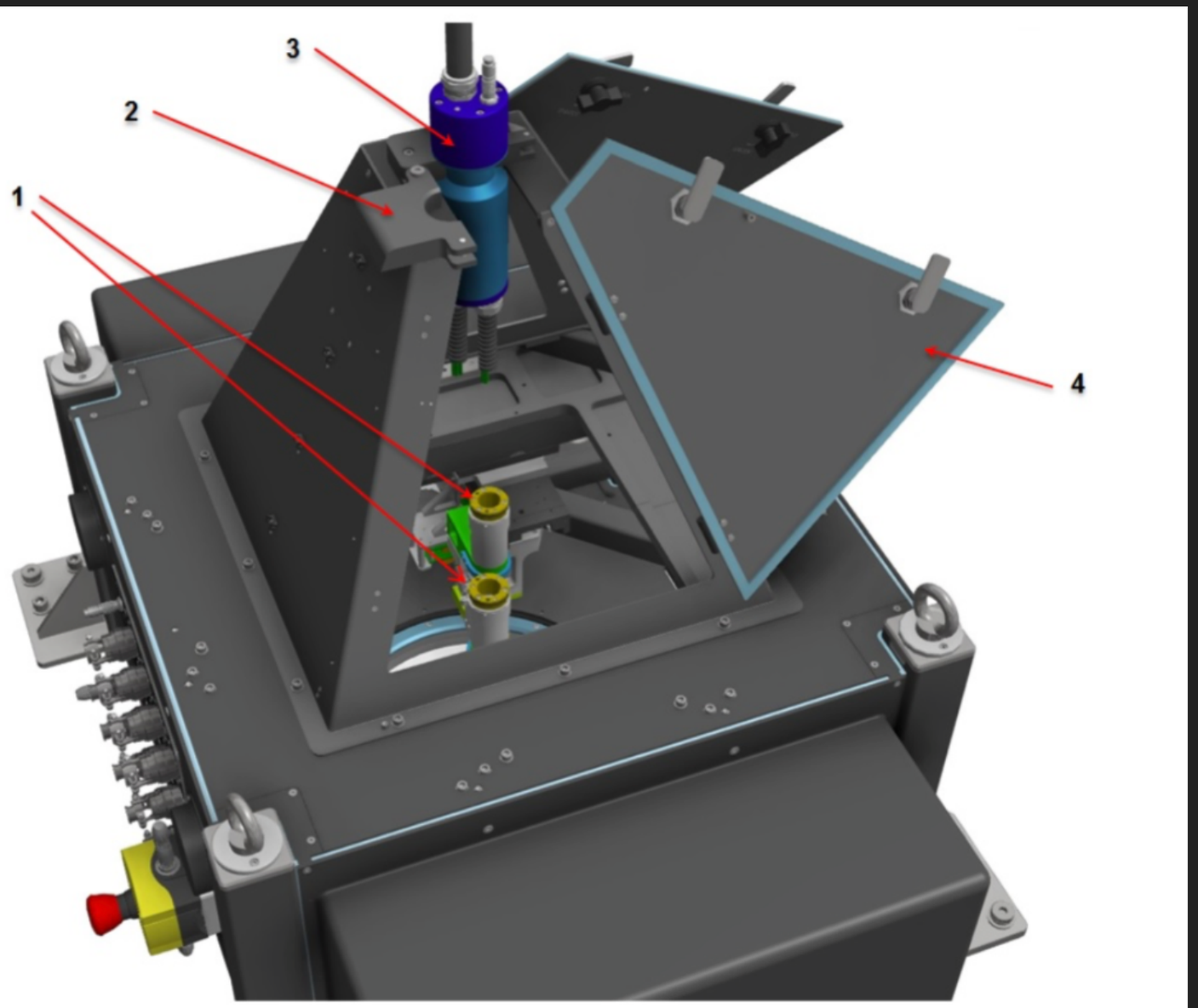
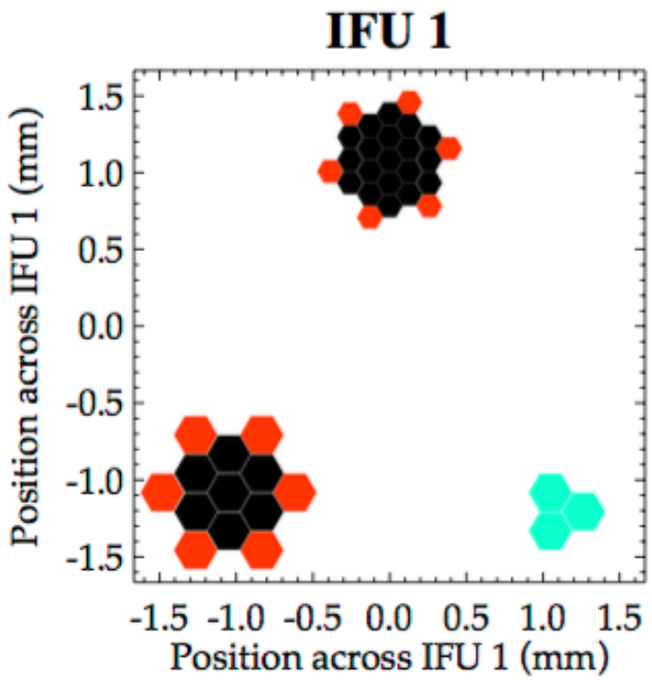
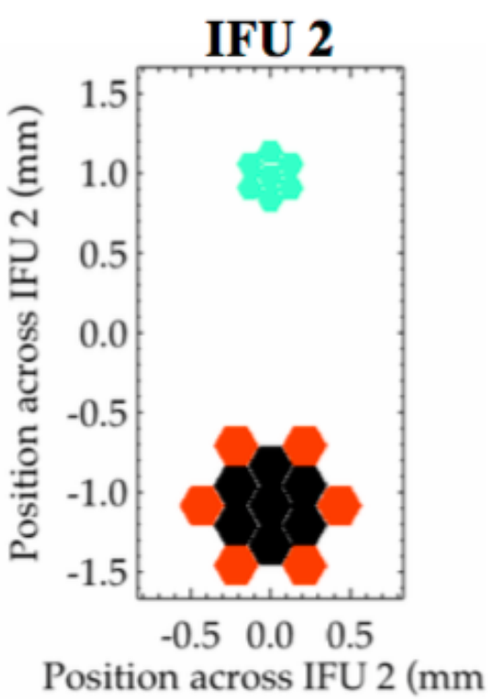


Figure 22 - Cable-IFU Positioners Interface.
1 – Optical Cable IFU mount; 2 – Manifold Clamp; 3 – Optical Cable manifold; 4 – Access Door

FIBER CABLE





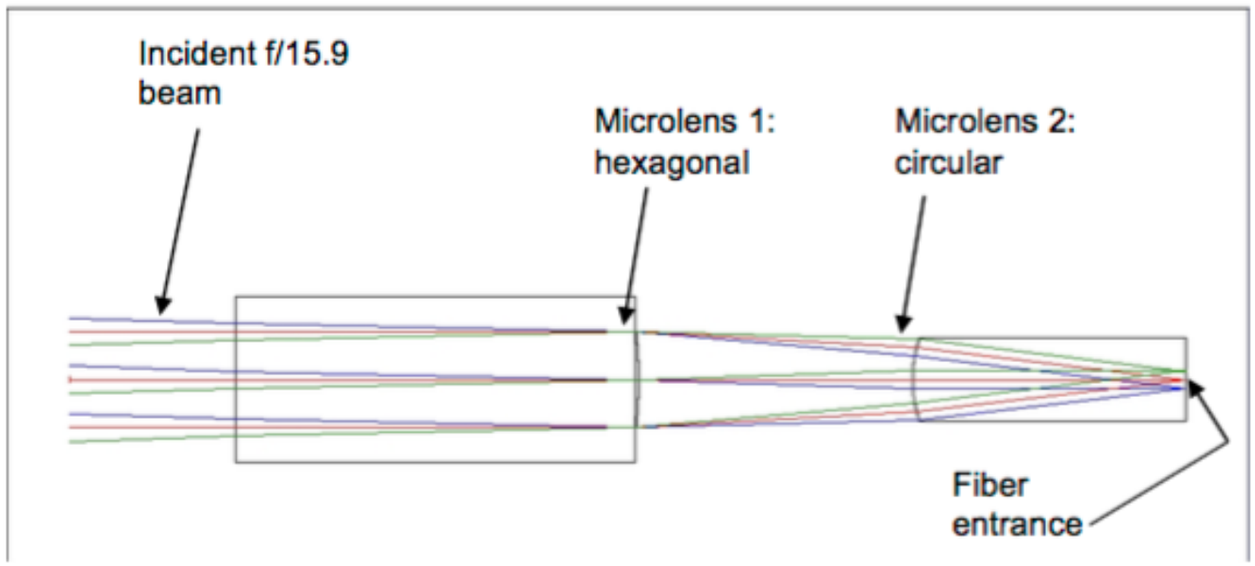


Figure 13 - Layout of the IFU injection system
One microlens pair is shown. The 3 different colors represent rays from 3 different points on the telescope exit pupil (the center and edges).

FIBER CABLE…2

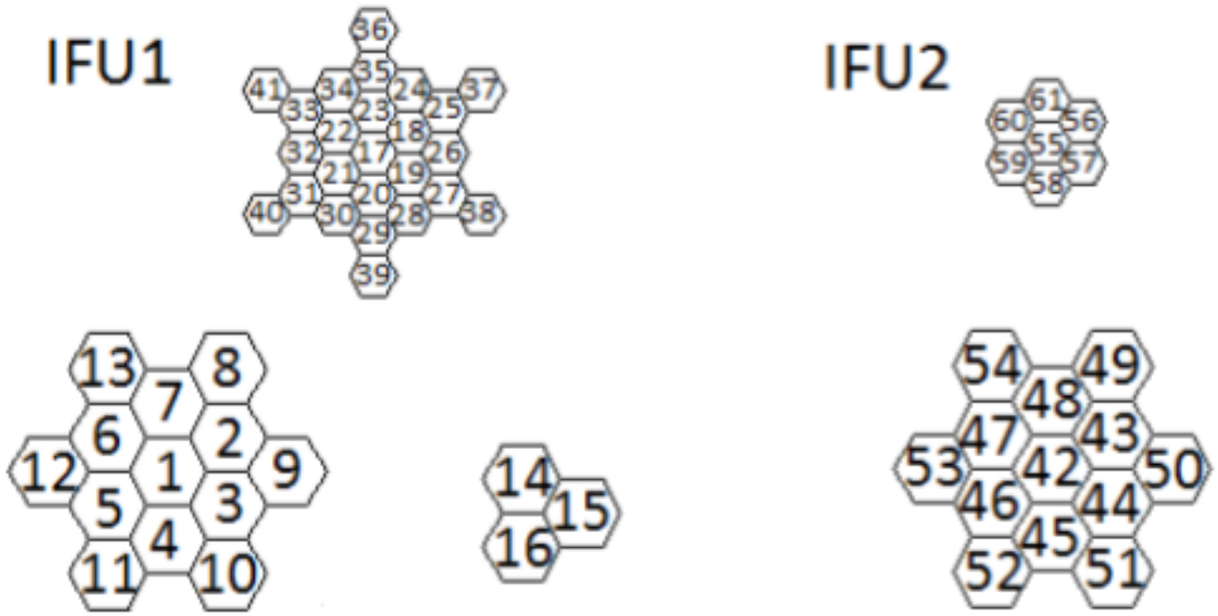
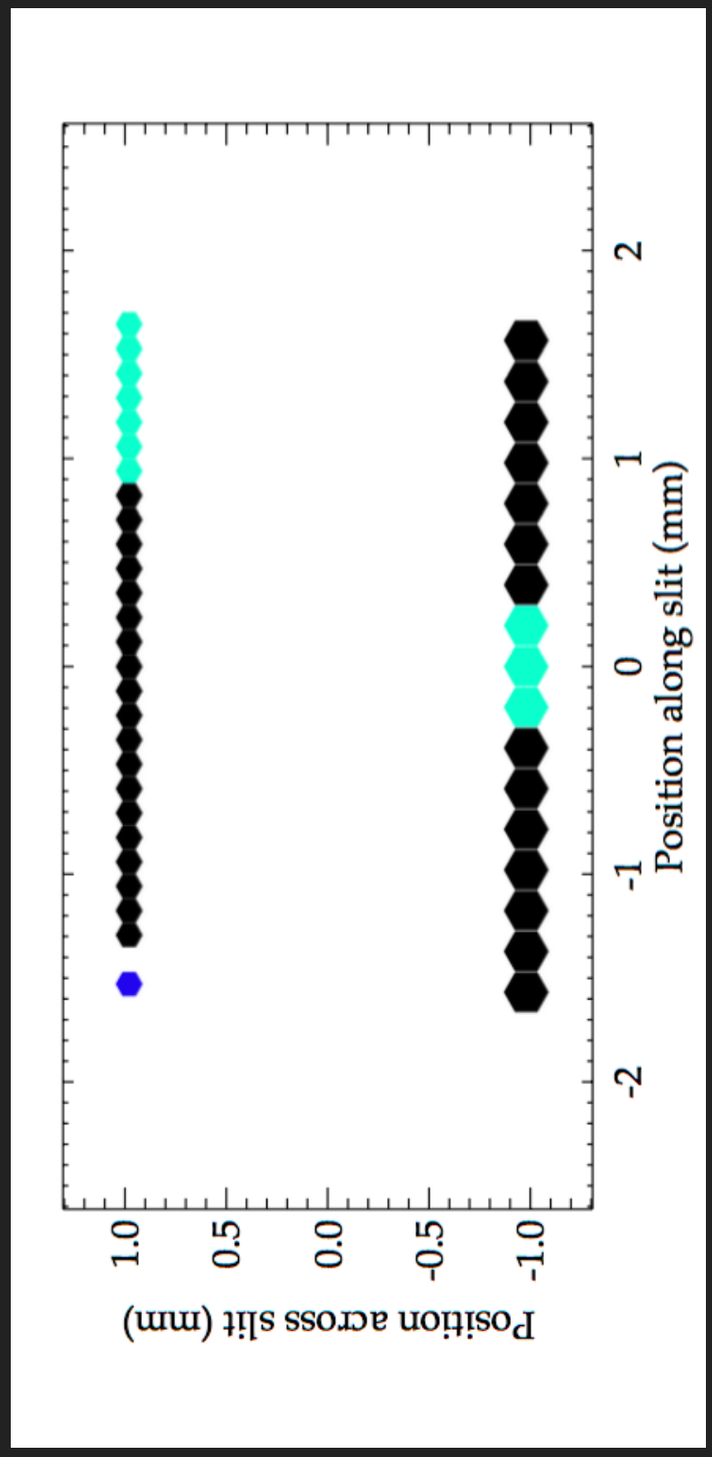
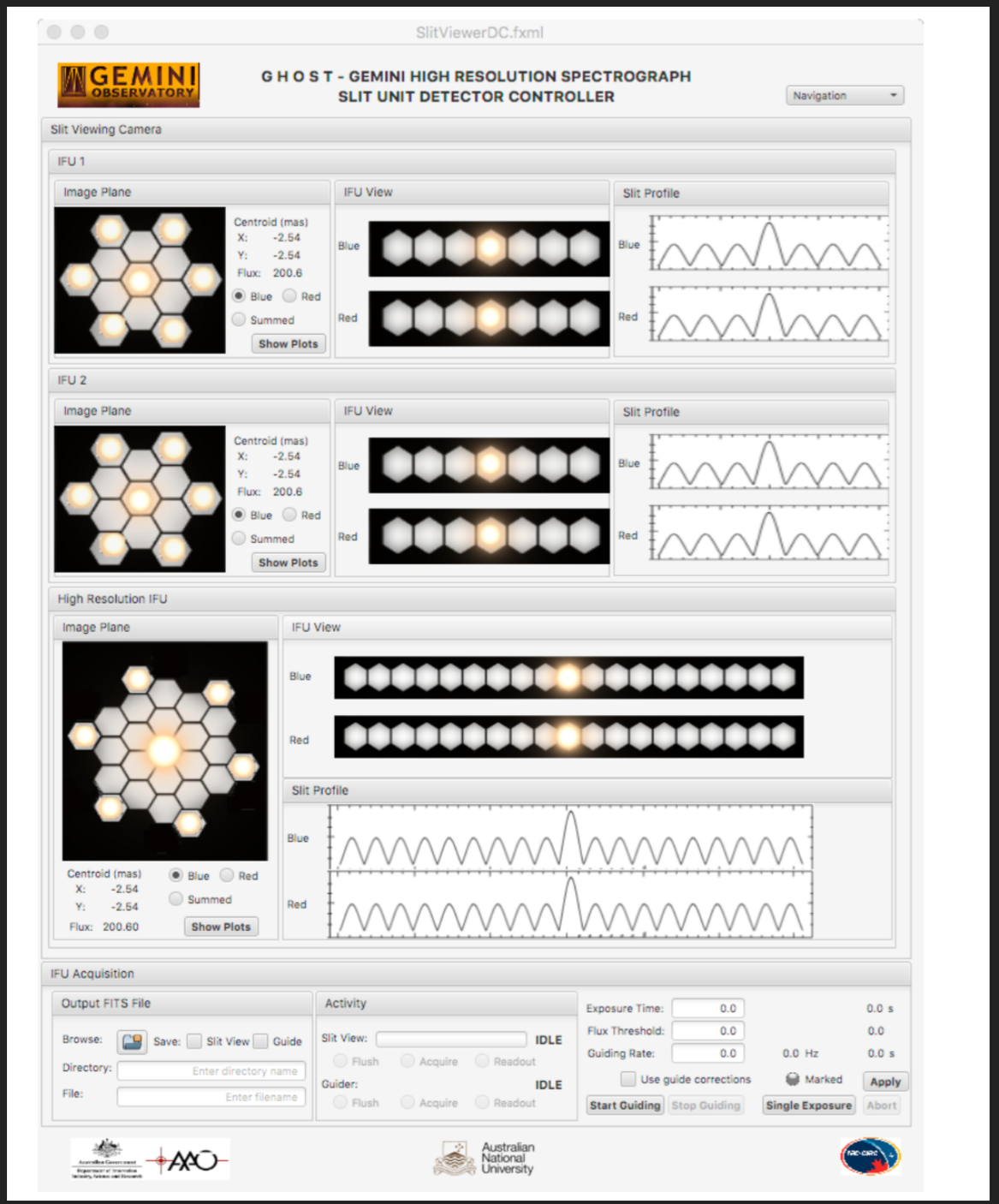


Figure 24 - Cassegrain unit IFU. Lenslet numbering

Figure 25 - Spectrograph slit. Lenslet numbering
Lenslet 62 is used by the ThXe calibration facility



SLIT VIEWER & GUIDING CAMERA



FIBER CABLE. . . 3

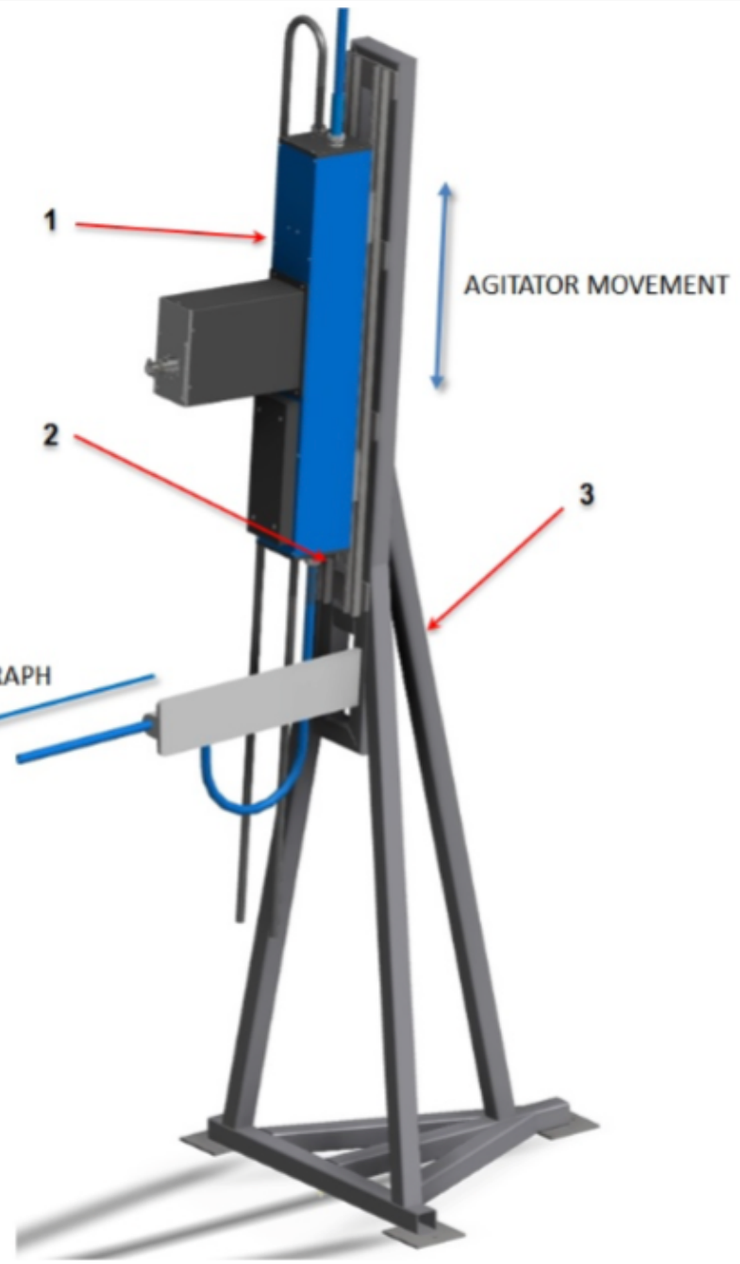
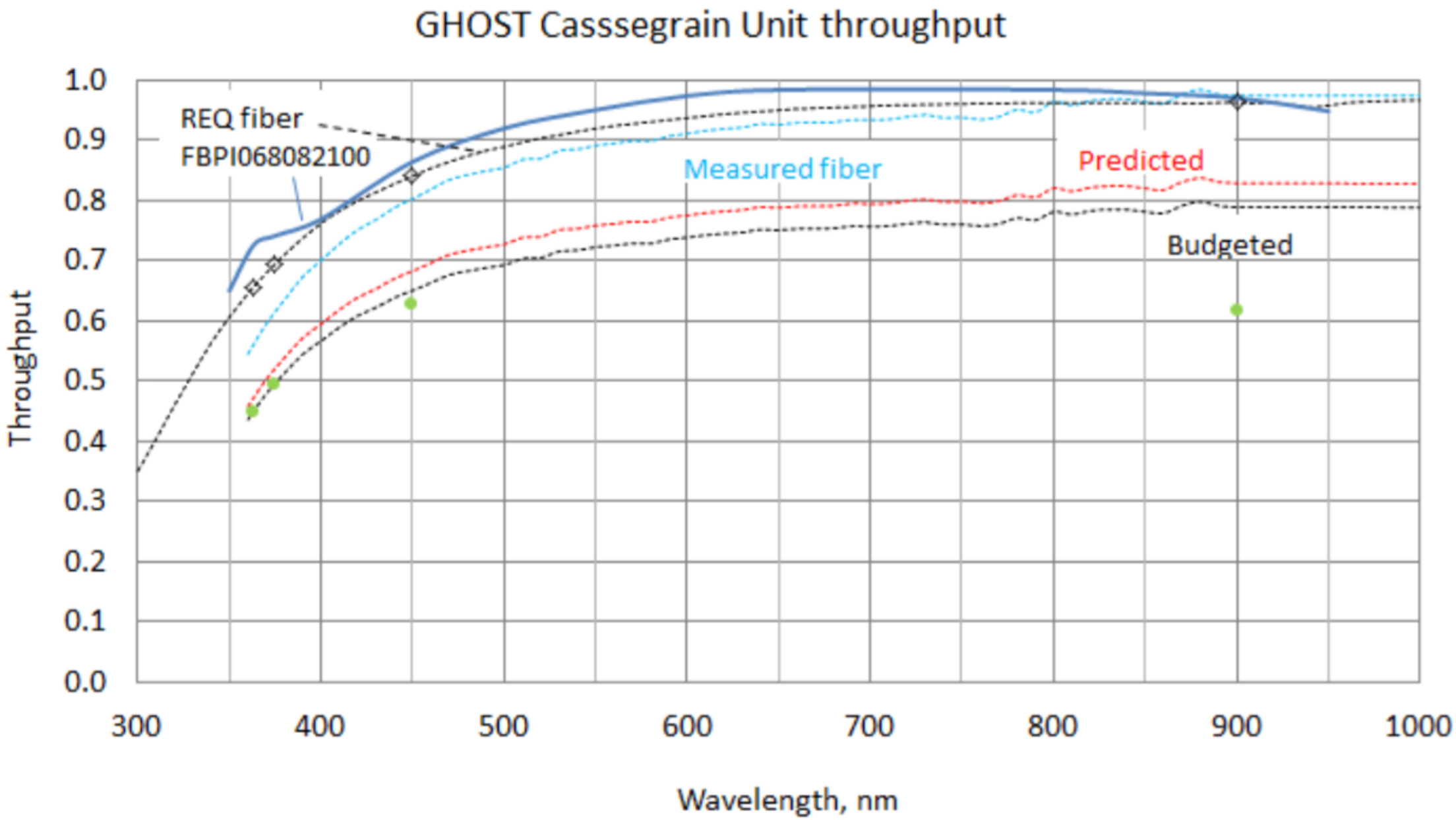


Figure 82 - Agitator mounted on the frame.
1 – agitator assembly; 2 – sensor location; 3 – agitator mounting frame.

FIBER PERFORMANCE



SPECTROGRAPH

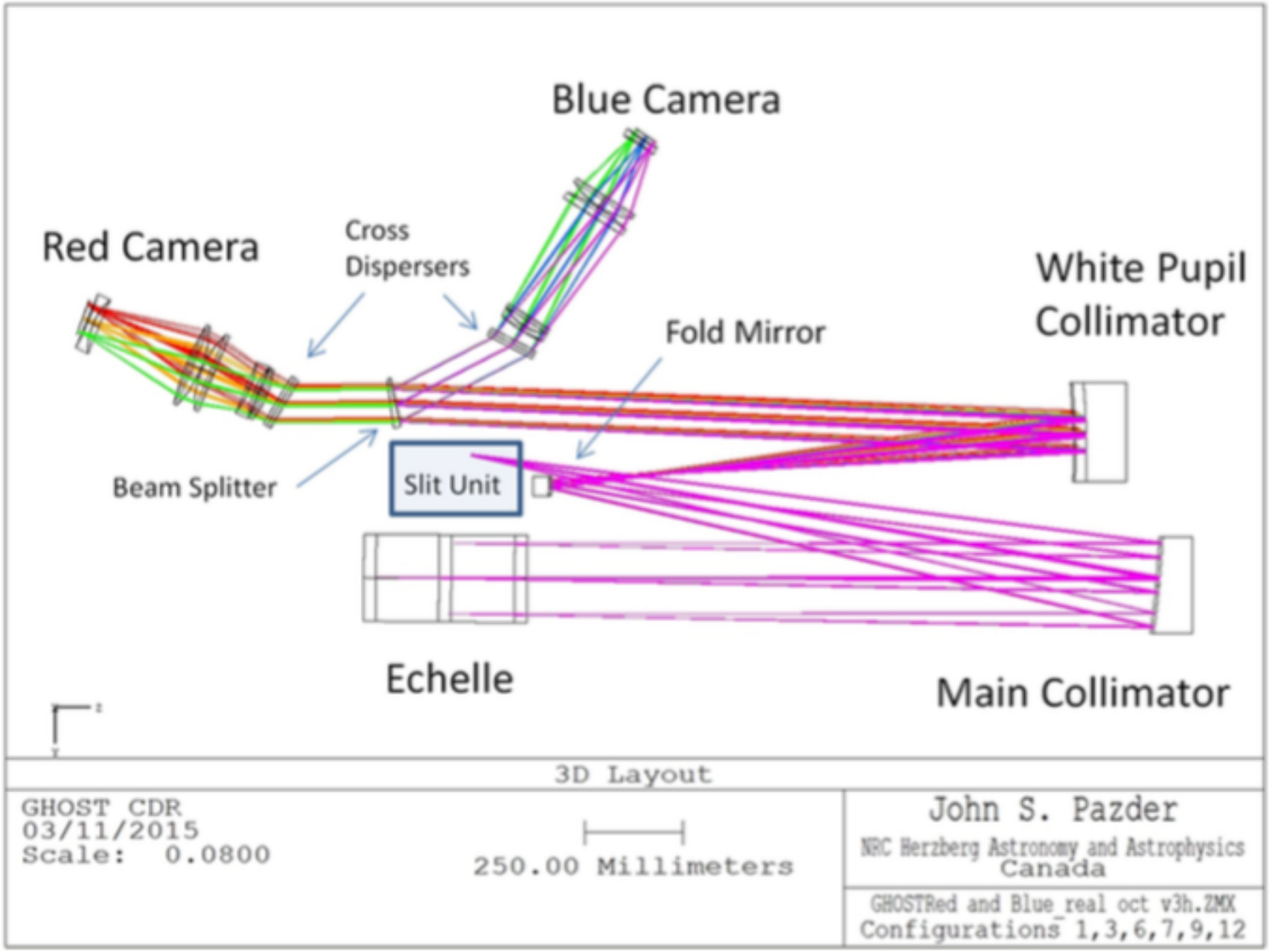
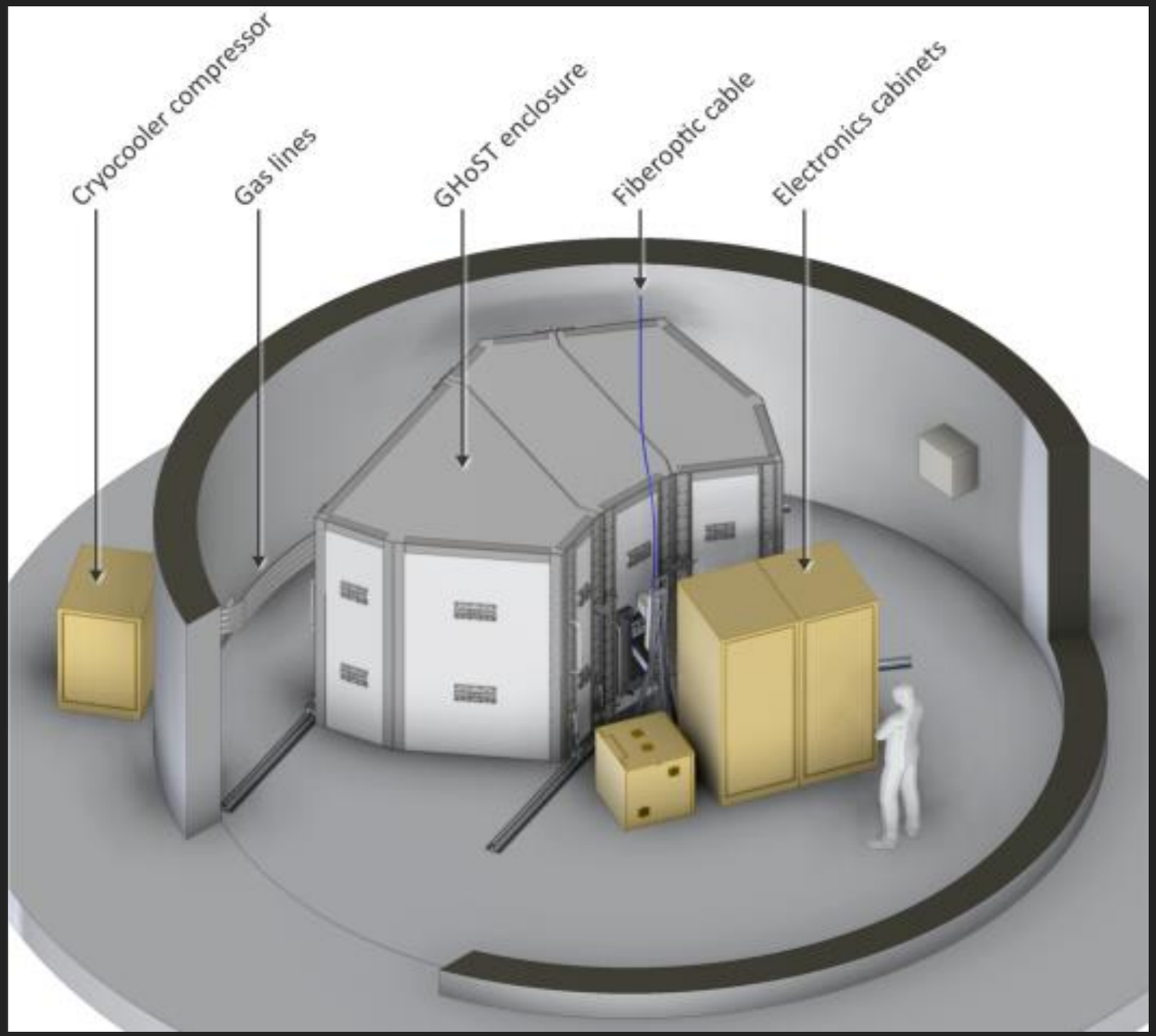
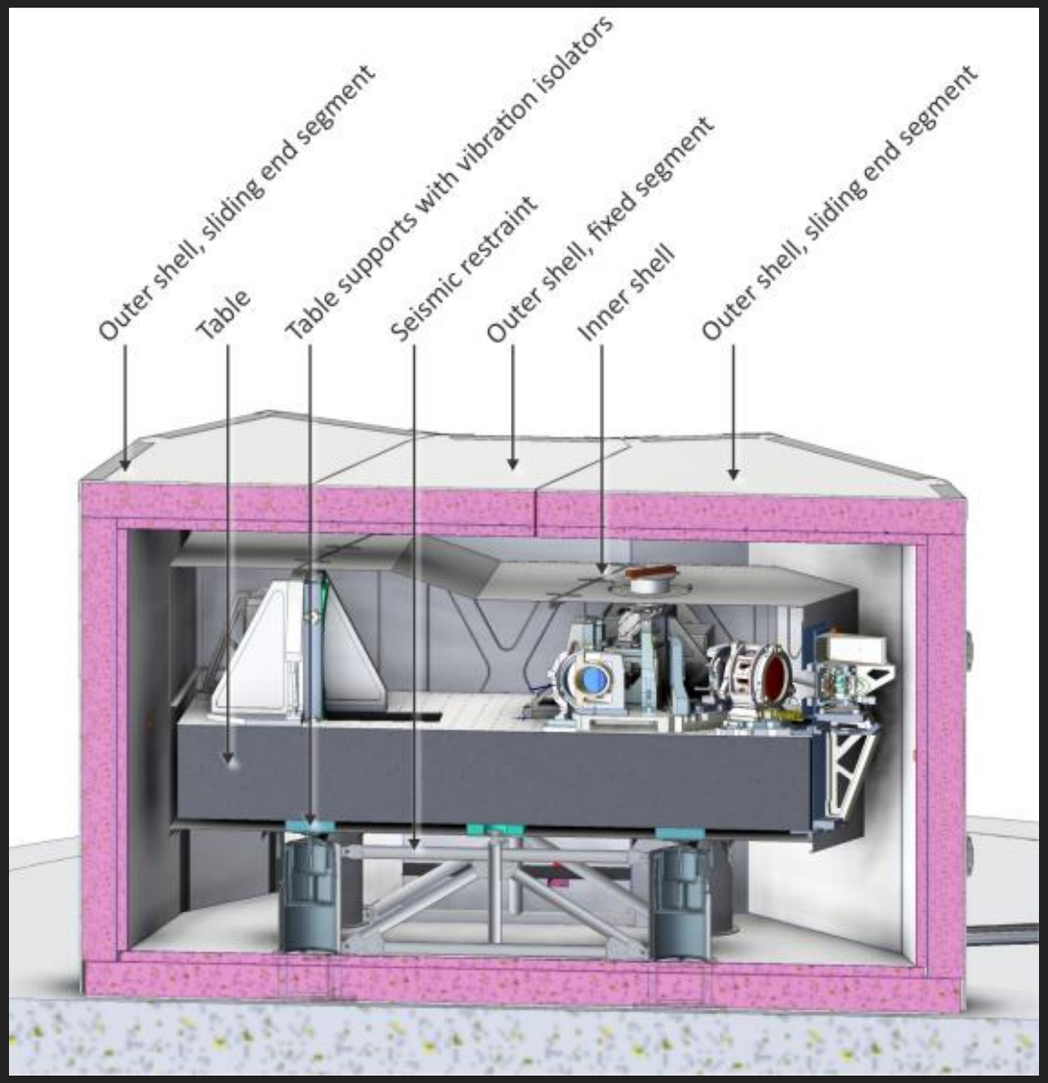


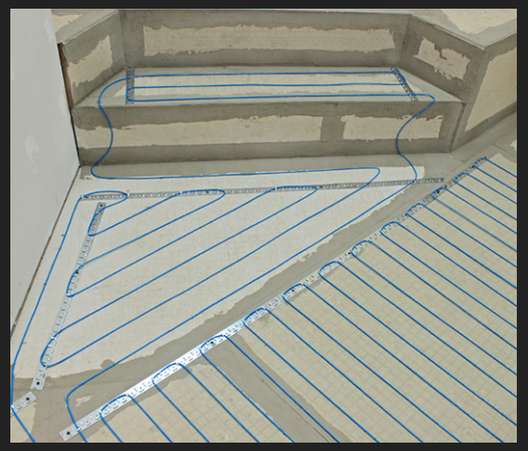
Figure 66 - GHOST spectrograph optical layout

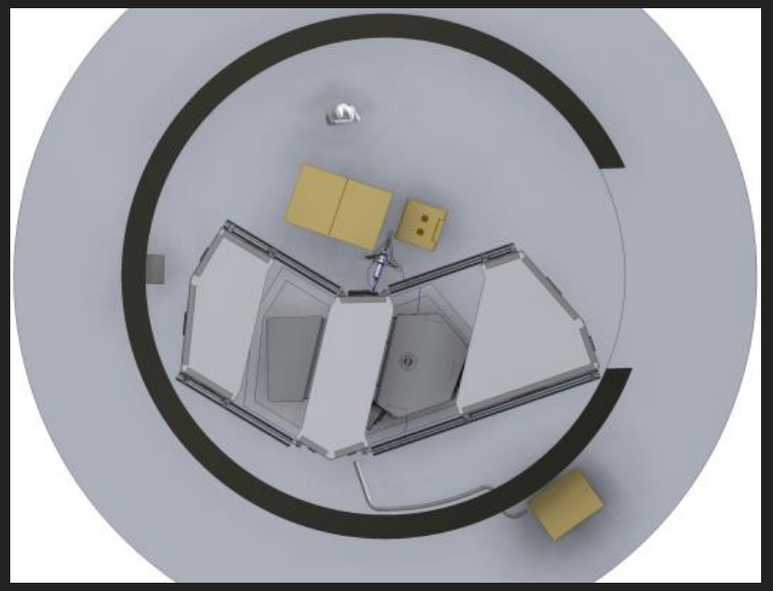
THERMAL ENCLOSURE

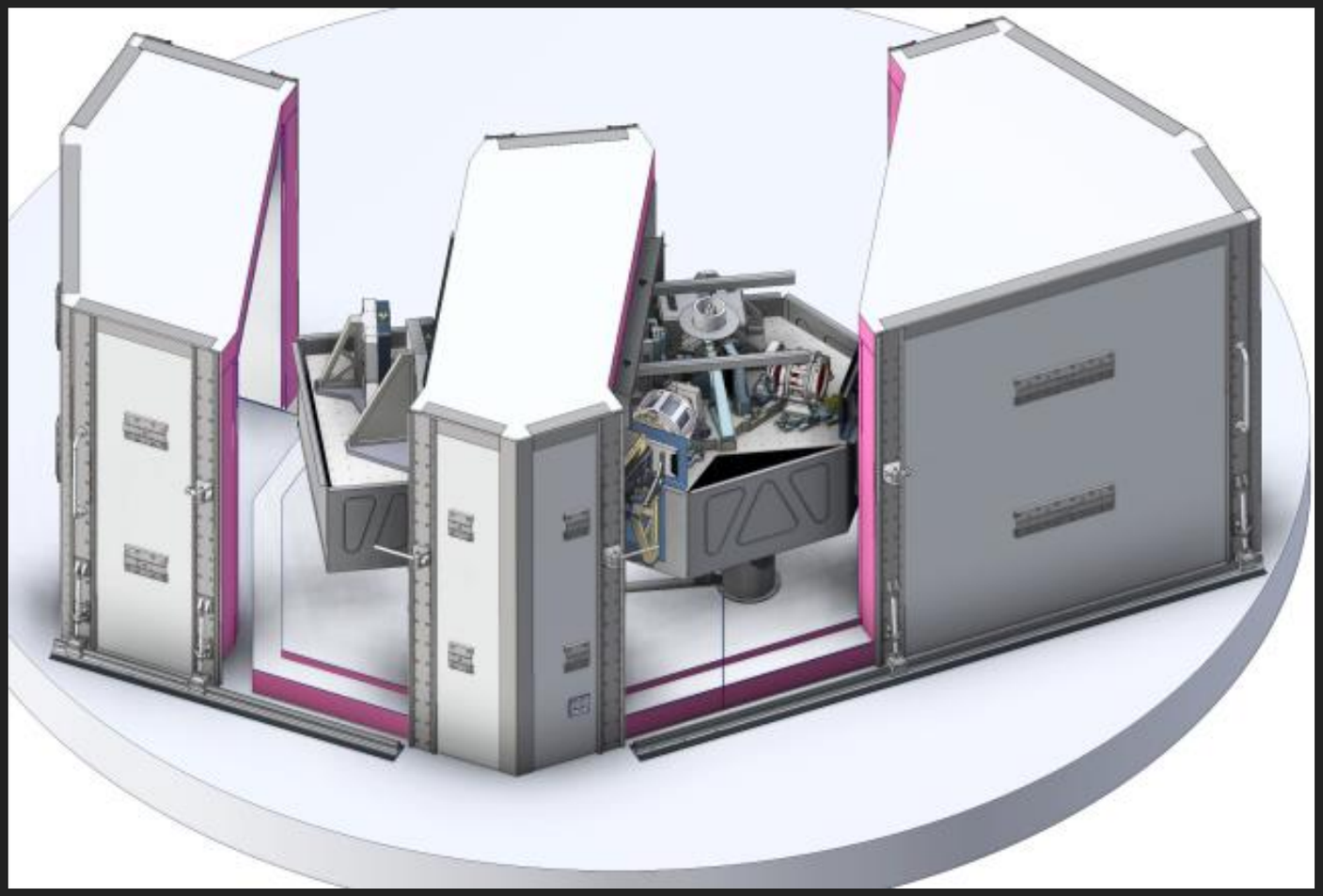


ENCLOSURE…2

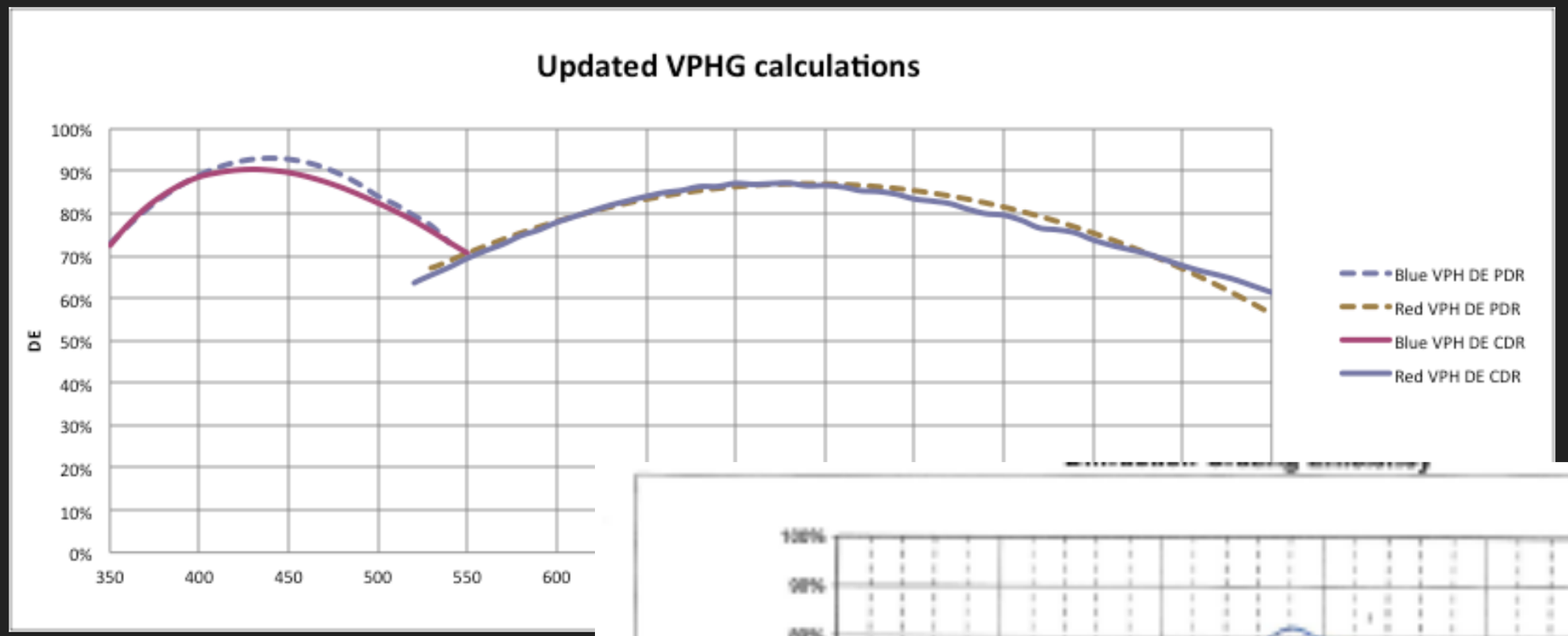

Outer shell, sliding end segment
Table
Table supports with vibration isolators
Seismic restraint
Outer shell, fixed segment
Inner shell
Outer shell, sliding end segment

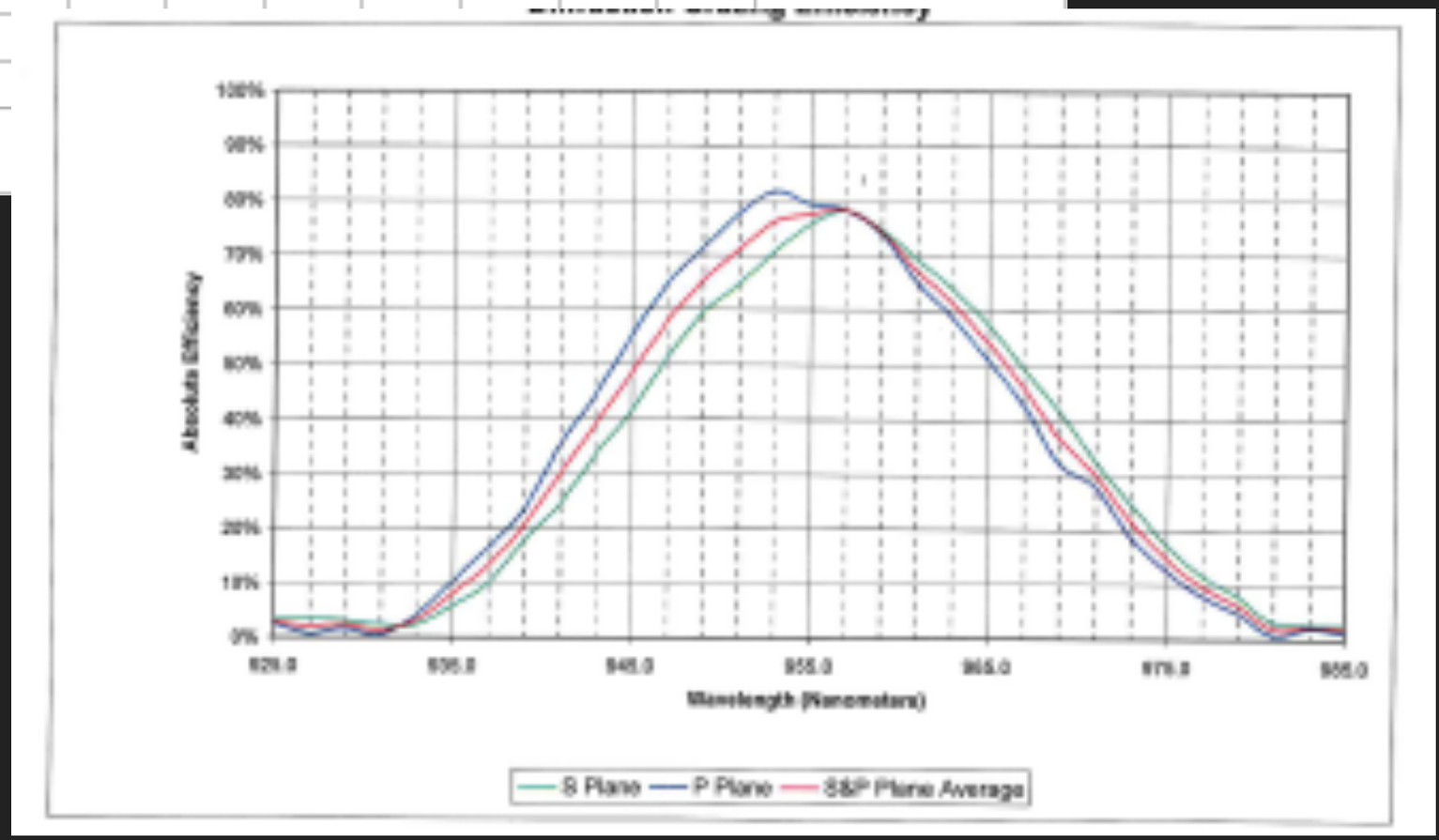




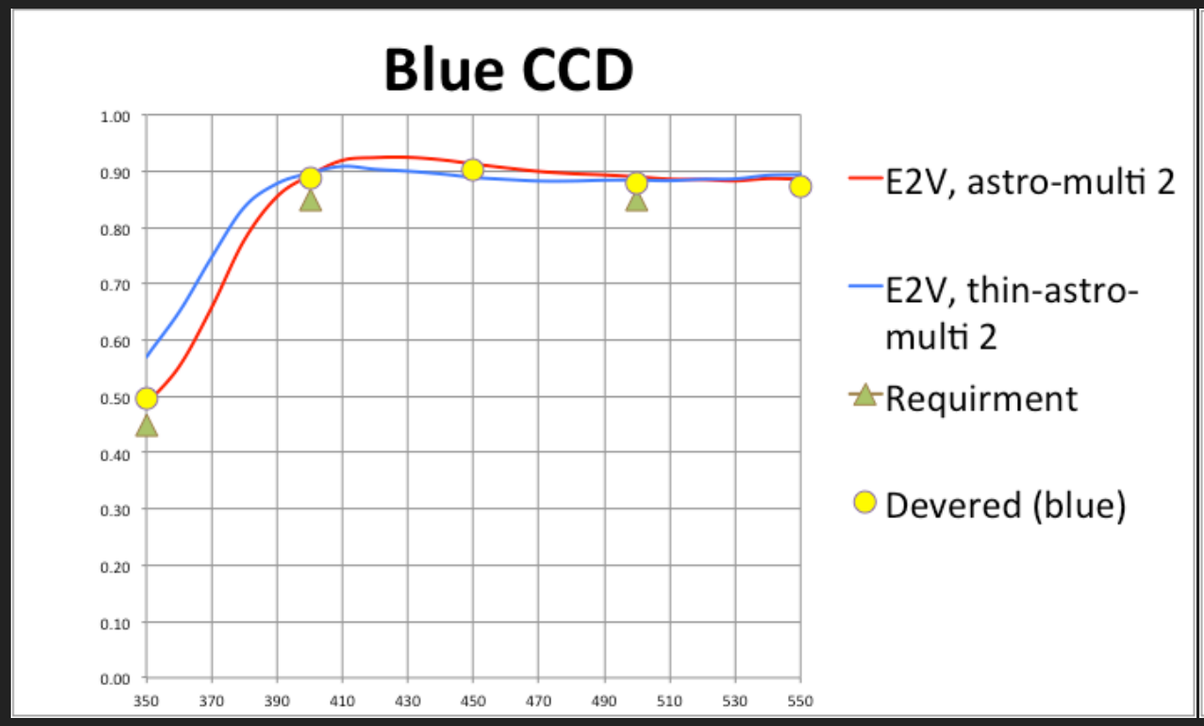


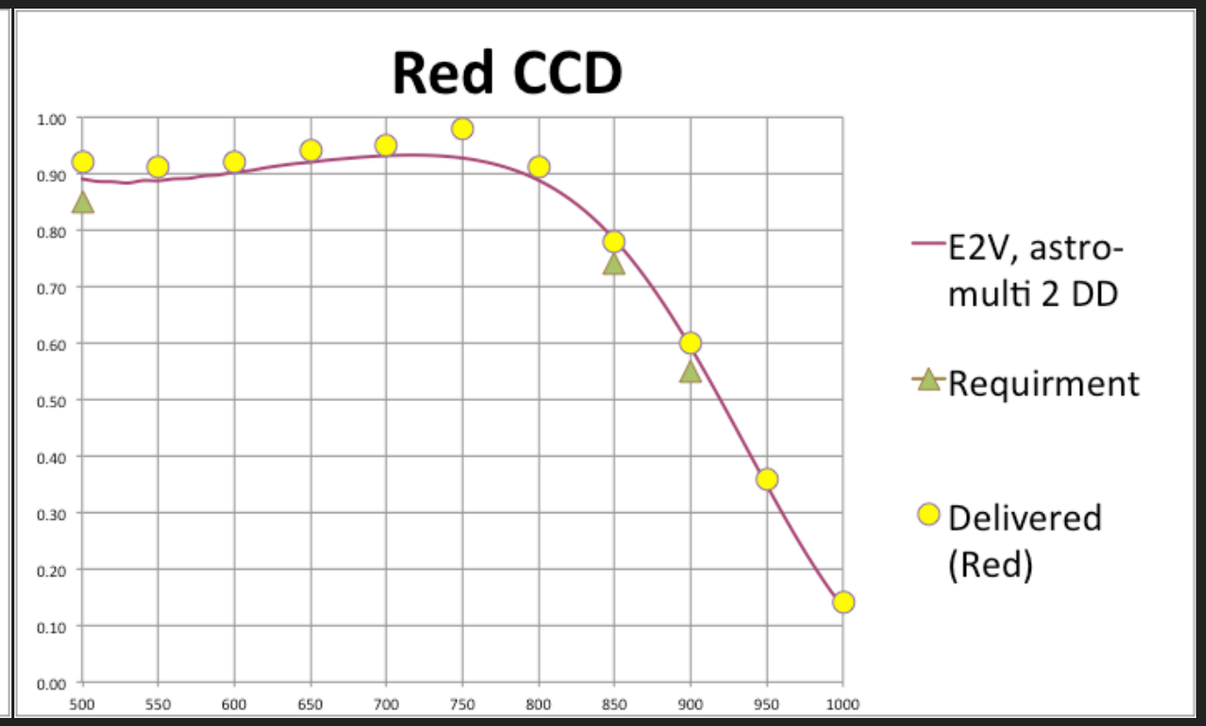
PERFORMANCE



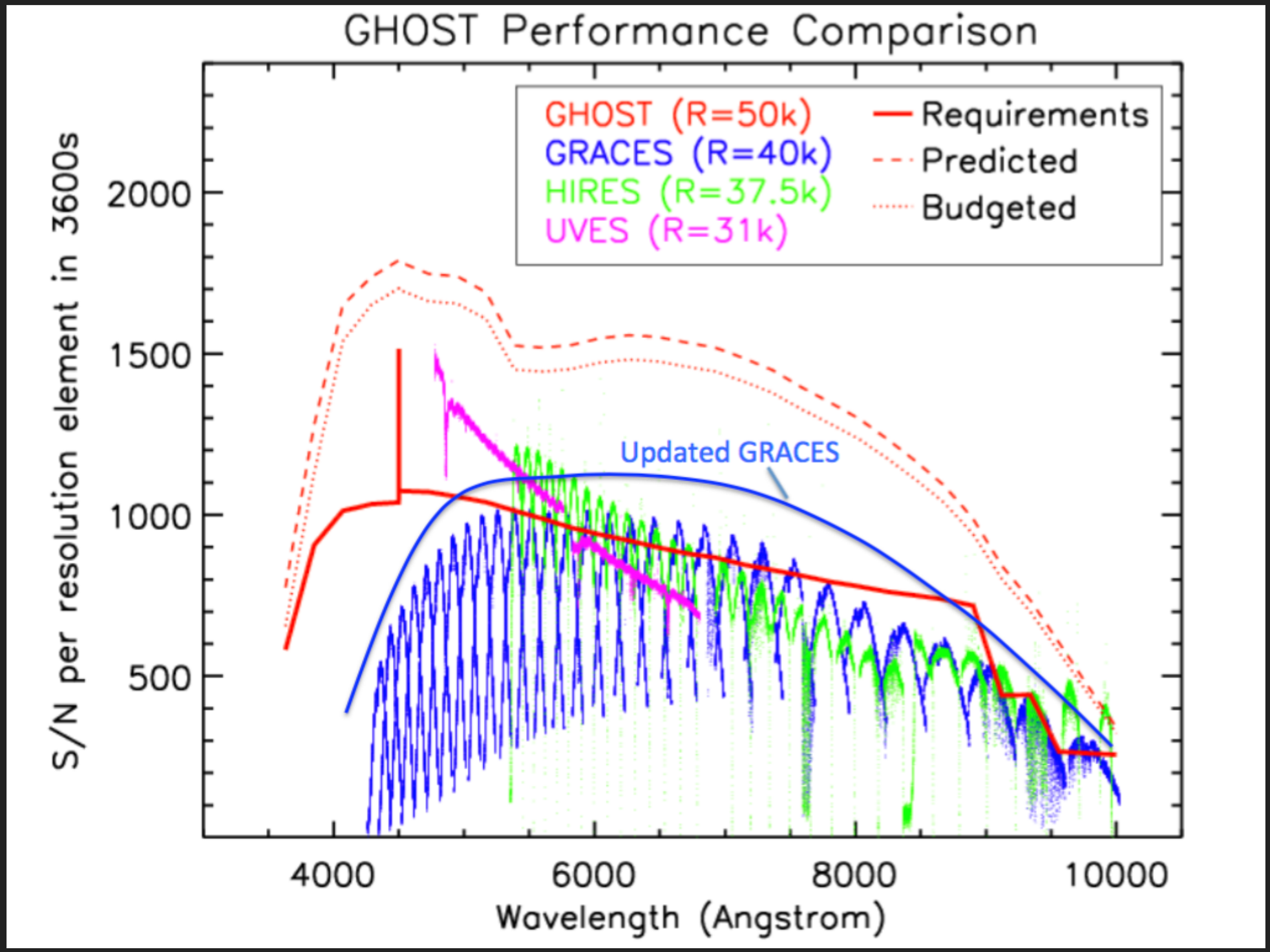


PERFORMANCE...2





PERFORMANCE

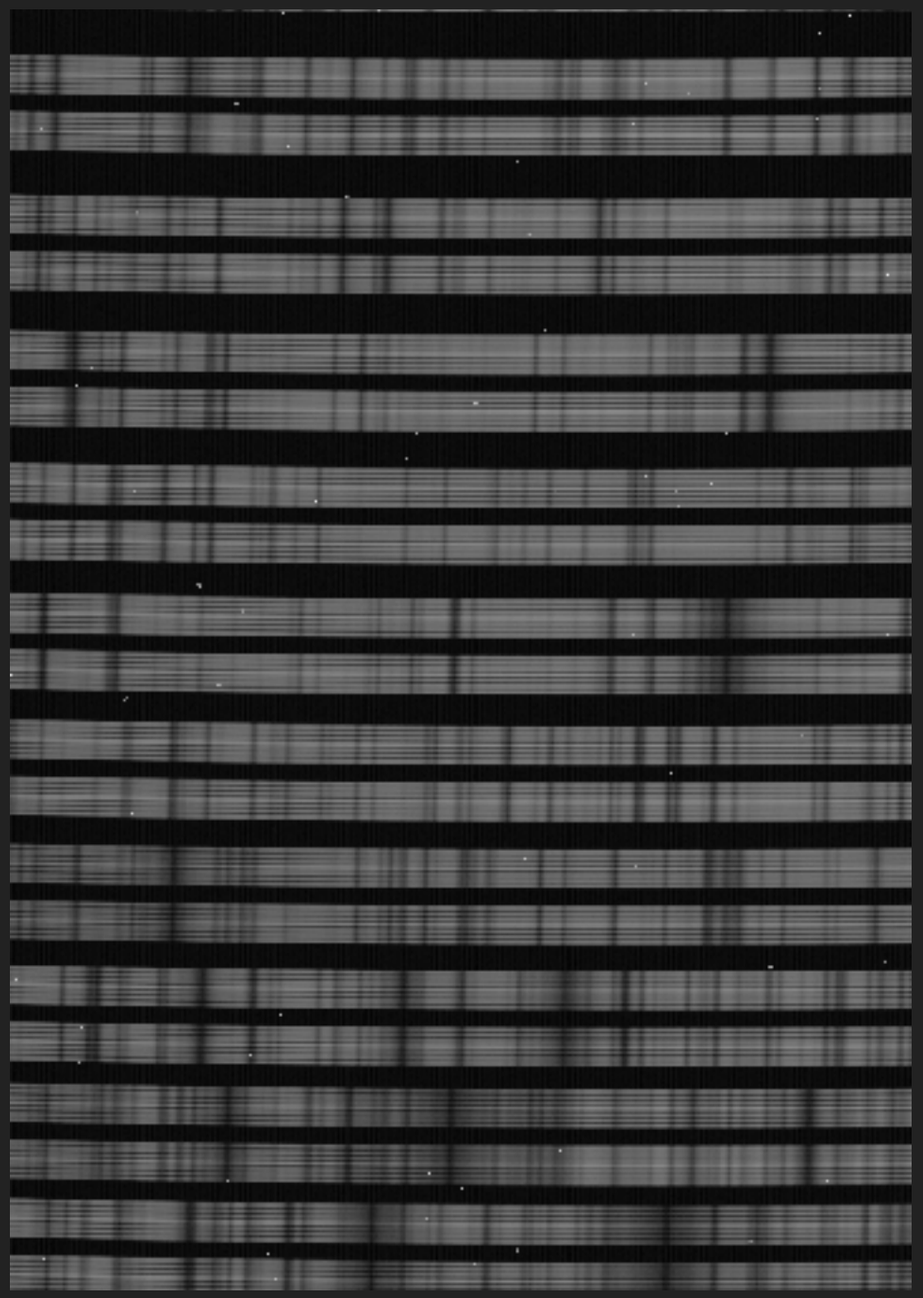


COMPARISON WITH OTHER HR SPECTROGRAPHS

Parameter	UVES	HIRES	MIKE	SALT-HRS	GHOST
Wavelength Coverage (nm)	300-1100	300 -1000	320-1100	370 to 870	363 to 950
Simultaneous Coverage (nm)	80 (blue), 200-400 (red)	300 to 620	335 to ~950	370 to 870	363 to 950
Number of Objects	1 (blue), 8 (red)	1	1 (5" slit, private fiber-fed mode)	1 (obj + sky)	2
Resolution	40k-80k (blue), 4k-110k (red)	85k	83k (Blue), 65k (Red) at 1" slit	67k (with slicing and loss)	50k + 75k
Efficiency at order centers	0.10 to 0.17, no slit losses	0.1 to 0.2	~0.3, no slit losses.	0.27 design, no slit losses.	0.1 to 0.2, including slit losses
RV precision (m/s)	~50 m/s (Molaro 2008)	~1 m/s (with Iodine[1])	~5 m/s (with Iodine)	Unknown[2]	600 m/s (std. res) 10 m/s (high res)
Aperture	0.5" slit	0.6" slit	0.5-1" slit	1.3-2.2" fiber	1.2" fiber
Polarimetry	No	No	No	No	Via upgrade

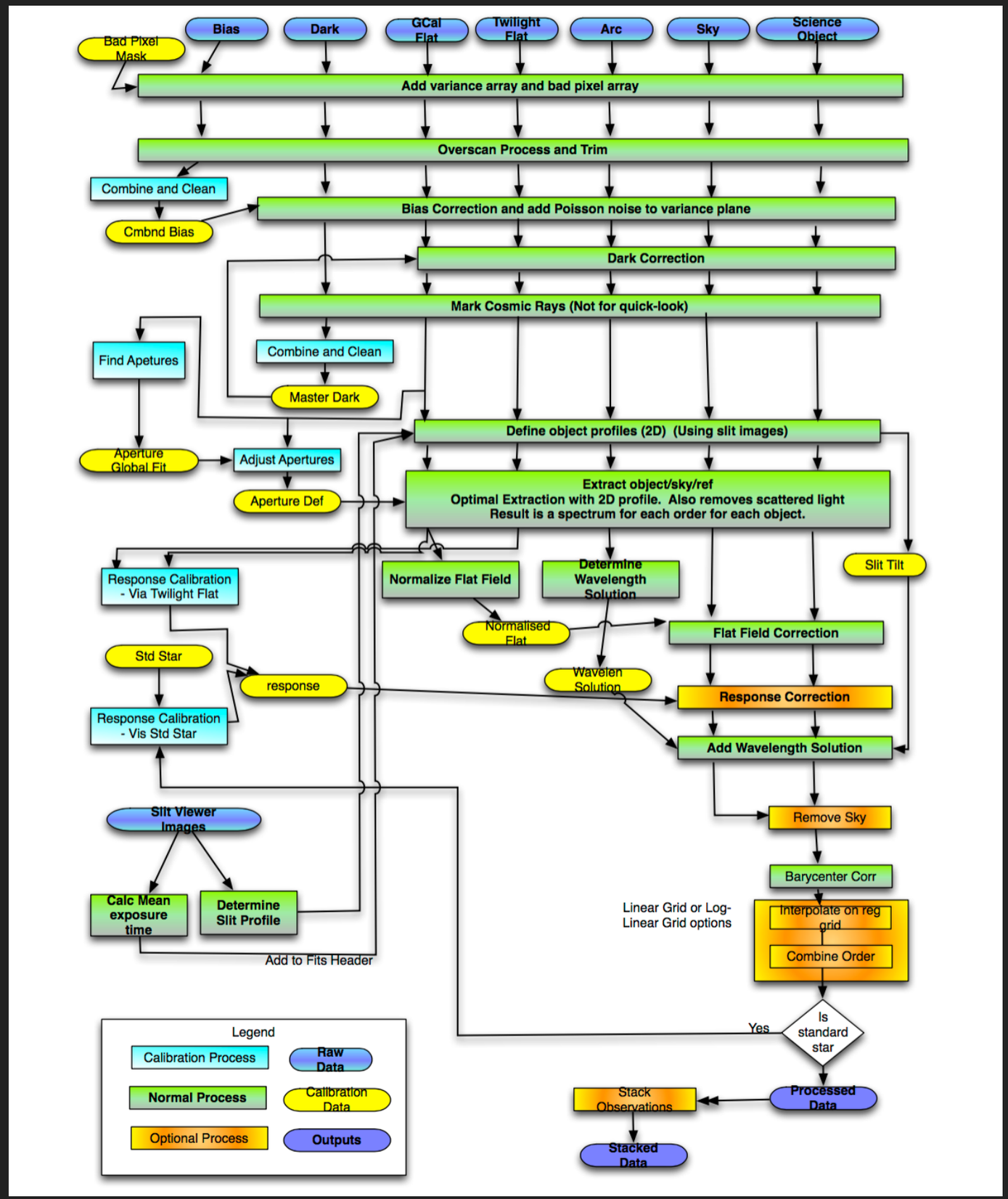
DATA EXAMPLE

DATA EXAMPLE…2



DATA REDUCTION

- DR Project @ ANU
- Completed before AT, commissioning
- Gemini DR Pipeline/ Recipe System
- Science-ready data products!!
- Not for PVR work



SCHEDULE

- Currently in build phase
- Integration and testing begins Q4 2017
- Commissioning mid-year 2018
- Early and demonstration science 2018B
- Community Access 2019A?